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Eye Worm of Chickens

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INTRODUCTION.

Many of the poultry raisers in and about Honolulu are familiar with the fact of the occurrence of a small, thread-like worm in the eyes of chickens. This worm is known as Manson's eye worm (*Oxyspirura mansonii*), and, so far as observations have been made, this is a parasite only in the eyes of chickens and peafowls. This worm has been reported as occurring in China, Brazil, Mauritius, Jamaica, Florida, and Hawaii. In all of the localities thus far reported as being infested with the eye worm of chickens the worm is found only near the sea shore, but the wide separation of the countries in which it is found would indicate that probably the worm is generally distributed throughout tropical countries.

The occurrence of species of eye worms in different birds and mammals is rather common. About 38 species of eye worm have been found in the eyes of 43 different species of wild birds throughout the world, and eye worms of other species have also been found in the eye balls or under the eye-lids in horses, cattle, sheep, dogs and geese.

The occurrence of the eye worm of chickens in Honolulu is

very general. An examination of chickens in all parts of the town indicate that the worm is found in nearly every flock. In a few flocks of fowls where a start was made by importing fancy eggs from the mainland or by buying eggs of poultry breeders in Honolulu, and starting the business by means of an incubator and brooder, no infestation by eye worm was found. If fowls are brought in from other flocks in Honolulu, however, a more or less extensive infestation is almost sure to be brought about. In cases of slight infestation there may be only two or three worms in each eye, while in badly infested flocks the number of worms may reach 50, 60 or more, in each eye of infested fowls.

ANATOMY OF THE EYE WORM.

The mature worm as found in the eyes of fowls ranges from a little less to a little more than one-half inch in length, and is about the diameter of a fine needle. Numerous measurements of mature worms indicate that the males vary in length from 10 to 14 millimeters, and females from 12 to 18 millimeters. The color of the worms is whitish or semi-transparent. No details of the anatomy of the worm can be seen by the naked eye. Since the average poultry raiser is not provided with a compound microscope and would at any rate have little interest in the microscopic anatomy of the worm it seems unnecessary to go into a discussion of anatomy in this bulletin, particularly since the subject has been so thoroughly covered by Ransom, in Bulletin 60 of the Bureau of Animal Industry of the United States Department of Agriculture.

LOCATION OF THE WORMS IN THE EYE.

Doubtless all poultry raisers are familiar with the gross external anatomy of the eye of fowls, and have observed a third eye lid, commonly called the nictitating or winking membrane, which lies underneath the two eye-lids and moves rapidly back and forth across the eye in a horizontal plane. When the eye is open the nictitating membrane is drawn back into the inner corner of the eye. Fowls and all other birds, wild and domesticated, as well, can therefore wink without moving the outer lids. The eye worms in infested fowls are found in the inner

corner of the eye, underneath the nictitating membrane. In full grown fowls the worms may therefore not be seen by a casual observation of the eye unless the nictitating membrane is lifted so that a view of the tear sinus or cavity underneath the nictitating membrane is to be had. In an examination of infested fowls in Honolulu as many as 50 or 60 mature worms have been found under the nictitating membrane of a single eye without any of the worms appearing in sight until the nictitating membrane was lifted. In small chicks from ten to twenty days old the sinus under the nictitating membrane is so small that the worms cannot remain concealed in it when the outer eyelids are opened, therefore the worms are seen wriggling over the whole surface of the eye.

METHOD OF EXAMINING THE EYE.

For the rapid examination of the eyes of poultry two persons can work together at better advantage than one alone. With the aid of an assistant, or by holding the fowl securely under the arm and holding the head motionless with one hand, one may press firmly with the thumb-nail over the tear pocket at the inner corner of the eye, and by rubbing gently, but firmly, may succeed in pressing some of the eye worms out upon the surface of the eye-ball, where they may be readily secured. This method of examining, however, is not very satisfactory, and the worms can never be removed completely from the infested eyes without a better system. The mature worms wriggle very actively and immediately disappear under the nictitating membrane after having been pressed out. No amount of manipulation by the method just mentioned will therefore secure a complete removal of the worms from the eye. The constant movement of the nictitating membrane in such manipulation in itself gathers the worms and carries them back into the tear pocket out of sight. If only two or three worms are present in a single eye, this method of examination might fail to discover them at all, and the erroneous conclusion might be reached that no infestation existed.

In the examination of the eyes of chickens, and particularly in any satisfactory treatment of the eye, either for the presence of eye worms or in the case of roup or sore-head, the use of a solution of cocaine has been found necessary as it is to oculists

in the examination of the human eye. The extreme sensitiveness of the eye brings about a rapid and continuous movement of the nictitating membrane, which makes it practically impossible to examine the eye thoroughly until it has been desensitized or anaesthetized by the use of cocaine. For this purpose a 5% solution of cocaine in distilled water is used, and may be applied to the eye from an eye dropper or by making a small swab of cotton on a toothpick, rubbing the solution over the surface of the eye. Within a few seconds the chicken makes no further resistance to an examination of the eye. A small swab, made by twisting a bit of cotton about the end of a toothpick, may be used for lifting the nictitating membrane in order to examine the eye and make it possible to drop remedies into the cavity under the nictitating membrane, where the eye worms are found. If the simple swab just mentioned be inserted under the nictitating membrane and pushed forward to the inner corner of the eye and moved upward and out from under the nictitating membrane again, a large proportion of the eye worms may be rubbed out from their hiding place. If two or three such passes with the swab are made without bringing a single worm to view one may be reasonably certain that no infestation of eye worms is present.

The use of a solution of cocaine in examining and treating the eyes of fowls gives us the means of making this examination more thorough and applying remedies with better effect than could possibly be accomplished in other ways. The method was first suggested by Mrs. W. J. Cooper, and has proved very successful in work at this Station. It is not only of use in examining and treating eyes for eye worm, but also in case of roup, sore-head, or any other eye trouble. It is impossible to lift the nictitating membrane and drop any solution into the pocket under the nictitating membrane without the previous use of cocaine; unless, however, the remedy is dropped immediately into the pocket under the nictitating membrane it is of little or no effect, particularly in the treatment of eye worms, for the reason that the presence of whatever remedy is used of sufficient strength to kill eye worms causes an immediate and excessive secretion of tears which dilute the solution of the remedy to such an extent that it is useless, or at least of no avail in killing eye worms. For example, the application even

of creolin or zenoleum by dropping it upon the surface of the eye by merely holding the two outer eye-lids apart will never result in destroying the eye worms in the eye, although these substances may be used in 5 or 6% solution. In applying remedies to the eyes of fowls we have observed that tears are formed in such quantity as to run down into the throat in almost a stream. The great quantity of liquid thus formed dilutes whatever remedy is used within a few seconds, so that it is of no further effect. When, however, the solution of creolin or zenoleum, which we have found most effective for the destruction of eye worms, is dropped directly upon the worms underneath the nictitating membrane, they are destroyed almost instantly.

TREATMENT FOR EYE WORM.

Several remedial measures have been suggested by previous investigators of this subject. These suggested remedies include irrigating the eye with a 1 or 2% solution of creolin or chloronaptholeum, a solution of bicarbonate of soda, and removal of the worms by the use of small forceps. As already hinted in the method of examining the eye, the use of forceps or any mechanical method for removing the worms is altogether too tedious and not effective; moreover, at least without the use of cocaine, it is likely to cause more injury to the eye than does the presence of the eye worm. Such weak solutions as 1 or 2% have not been found effective in killing worms in the eye.

In searching for better methods of destroying eye worms a number of remedies have been tried at this Station. Experiments were made first with worms previously removed from the eyes and placed in watch glasses. Under these conditions a 3% solution of zenoleum, a 1% solution of carbolic acid in 50% glycerin, or a one-half per cent solution of bichloride of mercury, would readily kill the worm. These remedies, however, had little effect on these worms in the eye. The contact of the remedy with the eye-lids and eye-ball causes an irritation which results in an excessive secretion of tears, thus almost instantly diluting the remedy used for destroying the worm. At first some hesitation was felt about using stronger solutions of irritant substances directly in the eye, and recourse was had to the use of more or less bland substances such as castor oil, engine

oil, kerosene, eucalyptus oil, cottonseed oil, boracic acid solution, certain proprietary eye washes, a 2% solution of permanganate of potash and peroxide of hydrogen. None of these substances was of any value, and the attempt was therefore made to use stronger solutions of creolin and zenoleum after anaesthetizing the eye by the use of a 5% solution of cocaine. When this method of preparing the eye is used and the solutions of creolin and zenoleum are dropped directly upon the worms in the pocket beneath the nictitating membrane a considerable percentage of the worms are destroyed, when either creolin or zenoleum is used in a 4% strength. Some of the worms, however, resist even this strength, and it was often necessary, in order to kill all of the worms in the eye, to use 5% strength of creolin and 6% of zenoleum. As already indicated even these strengths of the remedies in the eye are not effective unless the nictitating membrane is lifted and the solutions are dropped directly upon the worms. The dropping of these remedies in the eye causes a violent wriggling of the worms and a desperate attempt to escape, but they are killed almost immediately. If fowls treated in this way are examined 48 hours afterward no worms will be found in the eye, or occasionally a number of dead ones may be tangled together in a mass which is not easily removed by the motion of the nictitating membrane. The moment the solution of creolin or zenoleum comes in contact with the worms they straighten out and lose the power of holding themselves in the pocket under the nictitating membrane and are washed down through the tear duct into the throat. In one or two instances the dead worms were observed coming into the throat in some quantities together with the creolin solution which had been dropped into the eye. Doubtless any individual dead worms which remain in the eye after treatment and do not fall down through the tear duct into the throat would ultimately be removed by the motion of the nictitating membrane or would be dissolved in the eye fluid.

The treatment just described results in a slight inflammation and soreness of the eye, which persists for perhaps twenty-four hours, which, however, does not prevent the fowls from feeding. Treated fowls during the first twenty-four hours can open their eyes when they wish to feed, but when standing about during the heat of the day keep the eyes closed. Within forty-eight

or sixty hours the irritation caused by the remedy passes away entirely, leaving the eye in better condition than it was before treatment, as a result of the irritation caused by the eye worm.

This method of treatment was worked out in a long series of experiments upon adult fowls. In a poultry yard where unusual infestation of eye worms prevailed we had occasion to use the remedy on young chicks two weeks old. The method gave excellent results. In this case the young chicks were dying directly as the result of infestation of eye worms; on account of the small size of the eyes in the young chicks the worms wriggled across the whole surface of the eye-ball constantly, thus causing an irritation and inflammation of the upper and lower lids, nictitating membrane and cornea of the eye. The inflammatory exudation of the eye caused the lids to stick together so that the chickens were totally unable to see and soon died of starvation. In the case of these young chicks the treatment resulted in an apparent complete recovery in twenty-four hours. Similarly with the older fowls in the same poultry yard, some of which had developed a stumbling, staggering gait, from partial blindness or the acute irritation, these fowls also recovered within a few hours, and the owner of the fowls has since treated all of his chickens.

The treatment of eye diseases has always been a bugbear to poultry raisers, on account of the difficulties involved and the tediousness of the operation. Unless the eye is anaesthetized by cocaine the chicken wriggles its head so violently and moves the nictitating membrane so constantly that it is almost impossible to examine or treat the eye thoroughly, but by the method described in this bulletin, a poultryman who had never tried the remedy before found it possible to give thorough treatment to both eyes of sixteen fowls in an hour. The method therefore makes the examination and treatment of the eyes of poultry a practicable operation and one which will not be too tedious for any poultryman.

SYMPTOMS OF EYE WORM INFESTATION.

The symptoms caused by the presence of eye worms under the nictitating membrane in the eyes of chickens varies greatly in different cases. In some instances there may be from 20 to 50 worms in either eye without causing any apparent irritation or

inconvenience further than is evidenced by an occasional scratching of the eye on the part of the chicken. The presence of worms in the eyes of chickens, however, is not always an indifferent matter, and sometimes causes death without any other contributing causes, particularly in the case of very young chickens. The worms almost always cause some irritation as evidenced by the behavior of infested fowls. In most cases a certain amount of inflammation can be observed upon the cornea, the eye-lids and particularly in the nictitating membrane, which may become swollen and unusually distended. The excessive secretion of tears is an almost constant symptom of this trouble. In long standing cases the eye liquid may become thickened and purulent, resulting in the closing of the eye-lids and an inflammation of the eye-ball, terminating in its complete destruction. There are many cases of one-eyed chickens in which eye worms were the prime cause of the trouble. Naturally the presence of eye worms is also associated with the occurrence of roup and sore-head, since the irritation caused by the eye worms may give easy lodgement to the organisms which cause roup and sorehead. It often happens, therefore, that it is impossible to say just how much each one of these factors had to do with the ultimate destruction of the eye. In long standing cases where the purulent thickened liquid in the eye finally becomes caseous, no living eye worms can be found, but occasionally a few dead worms will be found embedded in this cheesy mass in the eye. While, therefore, eye worms can hardly be said to cause a specific disease, with uniform symptoms, they do frequently result in the death of the fowls, almost invariably render more easy the infection of fowls with roup and sore-head, and always cause considerable irritation in the eye, which may, as just indicated, result in a destruction of the eye or even in the death of the fowl.

THE LIFE HISTORY OF EYE WORMS.

Previous investigators of this subject have made no contribution to the life history of Manson's eye worm. Until the investigations reported in this bulletin were undertaken nothing was known of where the eggs were hatched, how and where the young worms pass their life, nor how, nor in what stage the worms gain entrance to the eyes of previously uninfested

fowls. Since, therefore, the life history of the worms was totally unknown it was thought very desirable to make an effort to determine this in part. While the method described proved quite efficient in destroying the worms in the eye it still seemed desirable to gain some idea of the life history of the worms in order to apply any additional method of control which might be suggested by the knowledge of the life history of the parasitic worm. An attempt was made to reach some definite information about the life history of the worm by a study of the various possible methods by which the worm might be transmitted from one fowl to another.

It had been suggested that the eye worm might possibly live for a portion of its life in the blood of infested fowls, or might be carried by the biting of insects. An examination was therefore made of the blood of numerous fowls infested with eye worms. No stages of the eye worm were found in this series of blood examinations. The only filarial parasite found in the blood was *Microfilaria seguini*. This organism had previously been found by Mathis and Leger, and Ransom, and has nothing to do with the life stages of the eye worm.

Infested fowls were thoroughly treated, so as to destroy all worms in the eyes, and were then confined in a mosquito proof house, on dry board floor, for two and one-half months. At the end of that time no worms were found in their eyes, and since no microscopic forms could be found in the blood, and none appeared in the eyes after the original infestation had been destroyed it was considered useless to make further experiments on the hypothesis that the worms were carried from fowl to fowl by any biting insect. An interesting fact observed by a number of previous investigators is that no eggs or larval forms of the eye worm can ever be found in the eye of infested fowls, no matter how badly infested they may be. We have made numerous careful examinations of the eye liquid from infested fowls and have never discovered a single egg or larval form of the worm in this liquid, although the eye may contain numerous mature female worms completely filled with eggs. It was at once suspected, however, since the eggs and larval forms are much smaller in diameter than the diameter of the tear duct that they would be promptly washed down through the tear duct by the flow of tears caused by the irritation of the

eye from the eye worm. We therefore began to examine the feces of infested fowls and found large numbers of eggs at once; in fact the minutest granule of feces suitable for one cover glass preparation under the microscope contains from 2 to 5 eggs. In all of the examinations which we made on the samples of feces we found but one freshly hatched larva. It appeared, therefore, that the eggs must hatch after passing out of the body along with the feces. The numerous eggs which we found in the feces and the one young larva were carefully identified by comparison with eggs from mature female worms and from larvae obtained by hatching such eggs in 1/10 normal salt solution. It was evident that these were washed through the tear duct by the eye liquid, issuing in the throat and then being swallowed, and then passing out with the feces. As already indicated we observed this process in the case of mature worms which could be readily seen with the naked eye. Of course the eggs and newly hatched larvae being only about .2 of a millimeter in size cannot be seen by the unaided eye. It is possible that the cases which we have observed of the natural disappearance of the worm from the eye may be taken as indicating that at complete maturity some of the female worms pass down through the tear duct and are disintegrated in passing through the intestines, thus setting free the numerous eggs which they contained.

A number of breeding experiments were then started by placing feces from infested fowls upon moist earth. In the first experiments we used ordinary bare soil, fresh from the garden, and in other experiments thoroughly sterilized soil. It was found that the growth of the young larvae was much more rapid in sterilized soil. Within three weeks in the case of unsterilized soil it is possible to find numerous young larvae about .2 millimeter in length. They were active and showed a number of methods of locomotion; in about ten days they were from .3 to .43 millimeter; after a period of three months a number of forms .5 millimeter were found. In the sterilized soil upon which the feces from infested fowls was placed numerous larvae were found within twelve days ranging in length from .2 to .8 millimeter. The soil was kept moist, or practically saturated, with sterilized water. One unhatched egg was found in the soil just underneath the feces even after 23 days, but at

that time nearly all of the larvae ranged in length from .4 to .66 millimeter. After a period of four months a number of larvae from .85 to nearly 1 millimeter were found in the sterilized soil. The live worms in this soil were so numerous that when a small particle of soil was placed in a watch glass to which a bit of distilled water was added, one drop of solution taken up in a pipette and placed on a microscopic slide would contain from 2 to 10 larvae.

Since the growth of the young worm in moist soil seemed to be so slow it was thought desirable to examine the soil about badly infested poultry yards. Opportunity was had to get soil of this sort in the case of an unusually severe infestation of eye worms in a poultry yard in Honolulu. In this case the fowls were allowed to run about the lawn, which was well grassed over except for small circular areas about the base of certain fruit trees. On these small areas of soil the fowls rested during the heat of the day, digging, dusting themselves, and such soil was badly contaminated with feces. This soil was kept moist by the application of water to the trees. In these circular areas about the trees samples of soil were taken, which revealed under the microscope untold numbers of larvae of the eye worm, as many as 20 being found in a single cover glass preparation. In the soil underneath the roosts in the simple poultry house in the case in question no larvae were found, but this is obviously to be explained by the fact that the soil was dry and kept constantly dusted with quick lime.

The young larvae of the eye worm in the soil are quite readily distinguished from the free living nematodes, which are abundant about the roots of various plants in tropical countries, by the facts that the eye worm larvae have no spear or projecting mouth parts and no striation upon the cuticle. By the time the larvae reach the length of about 1 millimeter the anatomical differences between the sexes begin to appear; the tail of the male is bent ventrally, as in the case of the adult, and the beginning of the spicula is seen.

It would appear, therefore, that the eye worm of chickens is essentially a facultative parasite, capable of living a large part of its life, probably to maturity, in damp soil, and then gaining entrance to the eye of fowls, where it lives as a true parasite. Similar conditions have been observed by Ercolani who car-

ried a number of parasitic nematodes through several generations in damp soil. The species with which Ercolani worked were *Strongylus filaria*, *S. armatus*, *Arcaris inflexa*, *A. vesicularis*, and *Oxyuris curvata*. The longest larva which we have thus far obtained from damp soil was about 1 millimeter, and the shortest immature worm which we have ever been able to find in the eye of chickens was about 4 millimeters. The cycle of the life history of the eye worm is therefore not quite completed, and the absolute proof that the worm gains its entrance to the eyes of fowls directly from the soil has not been brought forward the circumstantial evidence which we have produced, however, is so strong that it seems impossible to assume any other method of transmission. In the first place it is beyond question that the worms do not reproduce or multiply in the eye, only a portion of the life of one generation is passed in the eye. The eggs are immediately washed out of the eye into the tear duct and hatched in the soil after passing out of the body with the feces. Repeated experiments by other investigators and here at the Station have shown that fowls do not become infested when fed with material containing innumerable larvae of the eye worm. They cannot therefore disengage themselves from the food and pass up through the tear duct into the eye, nor have they the ability to reach the eye by passing through tissues, or otherwise, from the alimentary tract. We have also fed uninfested fowls with mature eye worms without producing any infestation. Similarly an infestation of the eye cannot be brought about by feeding eggs of the eye worm. We have tried placing the mature eggs and young larvae in the eyes of uninfested fowls without producing infestation: they were simply washed down the tear duct, as would have happened had eggs been laid by mature worms in the eye. It appears to be impossible for an eye worm to maintain a hold and keep its position in the eye until it has reached a size of at least 3 or 4 millimeters.

We found, however, that when mature or nearly mature worms are placed on the outside of the outer eye-lids they almost instantly wriggle into the eye. It seems, therefore, to be practically proved by circumstantial and other direct evidence that the eye worm gains entrance to uninfested fowls directly from the soil into the eye in the process of dusting and rolling

about in the soil, and in picking and scratching. The frequency with which fowls scratch the side of the head with the foot covered with soil in which they are digging has often been noticed, and the opportunity for the infestation of the eye, where the soil contains thousands upon thousands of eye worms, is exceedingly good. It is certain also that the worm gains entrance to the eye only after it has become nearly or entirely mature. The final evidence for this was obtained by finding a bad infestation with mature eye worms in chickens 10 days old. It was, of course, impossible in this case that any great amount of growth in the worms should have taken place after they gained entrance to the eye.

When infested fowls are kept in a cage with dry board floors, together with uninfested fowls no spread of the eye worm takes place so long as the boards are kept dry and the feces frequently removed. We have carried on the experiments with such direct exposure for five months without producing any infestation. When fully mature worms are removed from the eye of one fowl and placed in that of another they do not always remain more than a week or ten days. This apparently indicates that their life functions were at an end and they simply passed down through the tear duct. In one or two cases of bad infestation the worms completely disappeared from the eyes of infested fowls which were kept confined in a cage on dry boards. It is apparent, therefore, that so long as no opportunity from re-infestation is offered from infested soil a single infestation has a limited course and ends when the worms have reached complete maturity and disappear down the tear duct.

SUMMARY.

It appears from the investigations reported in this bulletin that the eggs of the eye worm of chickens are either laid in the eye, from which they are immediately washed into the throat by the flow of tears down the tear duct, or are set free in the intestines by the disintegration of mature female worms which had passed down the tear duct, through the throat, into the intestines.. The eggs hatch for the most part or altogether in damp soil, where they live until they attain at least one-third of their mature size, and then gain entrance to the eyes of chickens directly from the soil. The best treatment for the

destruction of the eye worms in the eyes of fowls consists in anaesthetizing the eye with a 5% solution of cocaine and then lifting the nictitating membrane and dropping a 5% solution of creolin directly into the inner corner of the eye, under the nictitating membrane. The fact that soil contaminated with the feces of infested fowls contains thousands of the larvae of the eye worm makes it obvious that means should be taken to destroy the young worms in such situations. This may be accomplished by applying quick lime and keeping the soil as dry as possible, and also by the frequent cleaning and removal of all feces from infested yards, or, in the case of bad infestations, by keeping the birds on dry floors which can be frequently cleaned until the infestation has disappeared.

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